construction
engineering
research
laboratory

CERL-SR-E-116
SPECIAL REPORT E-116
August 1977
Large Generator Set Test Procedures

STATIONARY GAS TURBINE-GENERATOR SET ACCEPTANCE TESTING PROCEDURES, METHODS, AND INSTRUCTIONS

Special rept.,

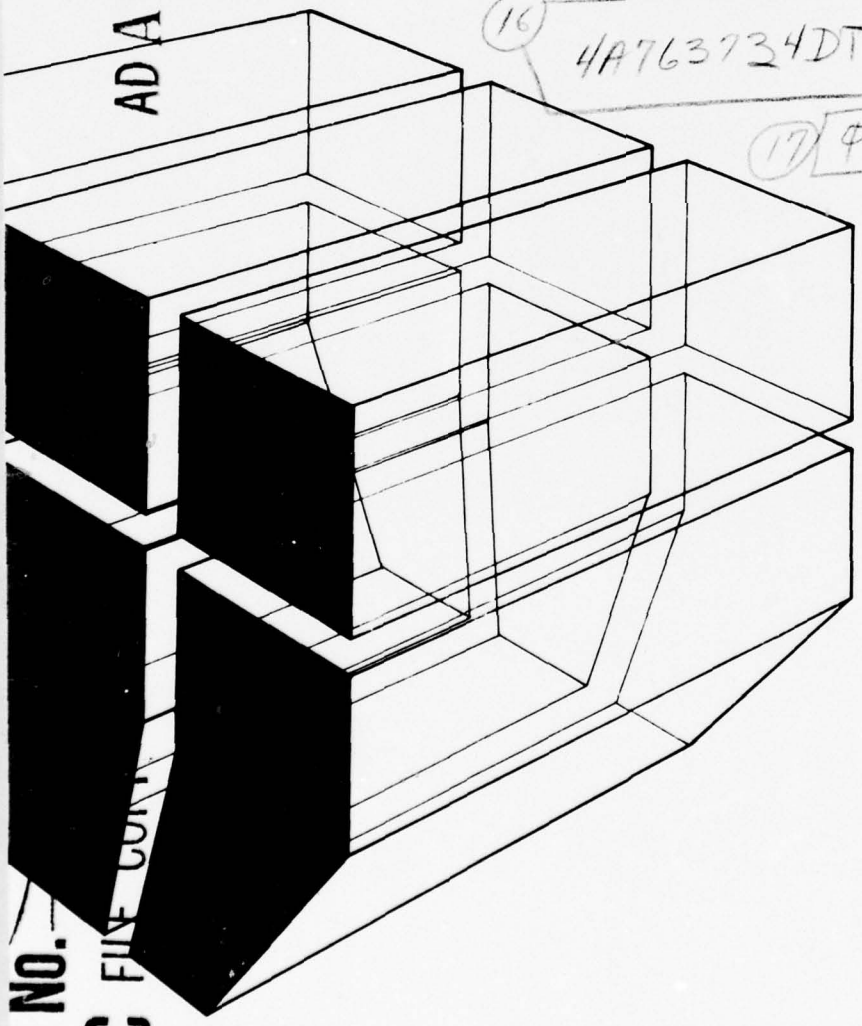
12

4A763734DT08

28 p.

Ø4

by
E. M. Takemori
S. W. Lee



405 279

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: CERL-SR-E-116	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE *(and Subtitle)*: STATIONARY GAS TURBINE-GENERATOR SET ACCEPTANCE TESTING PROCEDURES, METHODS, AND INSTRUCTIONS	5. TYPE OF REPORT & PERIOD COVERED: SPECIAL
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): E. M. Takemori S. W. Lee	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: CONSTRUCTION ENGINEERING RESEARCH LABORATORY P.O. Box 4005 Champaign, IL 61820	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 4A763734DT08-04-001
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: August 1977
	13. NUMBER OF PAGES: 28
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*
Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES
Copies are obtainable from National Technical Information Service
Springfield, VA 22151

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*
gas turbine generator sets
acceptance testing

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report establishes procedures for acceptance testing gas turbine-generator sets intended for installation in fixed military facilities.

The new test procedures, numbered CE-TP-2001 through 2003, are designed for use by Corps of Engineers Division and District personnel. Also included are lists of MIL-STD-705B test methods and Corps of Engineers diesel engine generator set test procedures that apply directly to acceptance testing gas turbine-generator sets.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

FOREWORD

This research was conducted for the Directorate of Military Construction, Office of the Chief of Engineers (OCE), under Project 4A7-63734DT08, "Military Construction Engineering Development"; Task 04, "Engineer Energy Development"; Work Unit 001, "Large Generator Set Test Procedures." The applicable QCR is 1.05.004. The OCE Technical Monitor was Mr. S. Berkowitz (DAEN-MCE-U).

The study was conducted by the Electrical Mechanical Branch (EPM), Energy and Power Division (EP), U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL. CERL Principal Investigator was E. M. Takemori. Mr. M. J. Pollock is Chief of EPM and Mr. R. G. Donaghy is Chief of EP.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director.

CONTENTS

STATIONARY GAS TURBINE-GENERATOR SET
ACCEPTANCE TESTING PROCEDURES,
METHODS, AND INSTRUCTIONS

1 INTRODUCTION

Problem Statement

Corps of Engineers (CE) Division and District personnel must currently perform acceptance testing of large gas turbine-generator sets within fixed military facilities without testing procedures since none presently exist.

To resolve this problem, the Advance Technology Branch of the Directorate of Military Construction, Office of the Chief of Engineers (OCE), requested the U.S. Army Construction Engineering Research Laboratory (CERL) to develop acceptance testing procedures specifically for gas turbine electric generators and gas turbine electric generating plants.

Purpose and Scope

The purpose of this report is to establish specific, standardized methods for obtaining measurements needed to test and evaluate the performance of gas turbine-generator sets and related components intended for installation in fixed military facilities. The procedures developed are intended for use by Corps of Engineers Division and District personnel in writing specifications for procurement documents and in determining compliance with the requirements set forth. Failure criteria are not established. The procurement document requirements paragraph, included as the final paragraph of each test method, indicates the data required for the purchase description.

The procedures in this document are to be used in conjunction with MIL-STD-705B, MIL-HDBK-705B[1] and CE Diesel Engine Generator Set Test Methods.[2] All possible applicable MIL-STD-705B and CE diesel engine generator set testing methods are listed in Chapters 2 and 3. The applicable tests should be selected for any procurement. Terminology, instrumentation, methods of measurement, and general electrical technology are contained in MIL-HDBK-705B.

---

[1] *Generator Sets, Electrical, Measurements and Instrumentations*, MIL-HDBK-705B (Department of Defense, June 1976).

[2] E. M. Takemori, S. W. Lee, and M. A. Gazda, *Stationary Diesel Engine-Generator Set Acceptance Testing Procedures, Methods, and Instructions*, Special Report E-103/ADA037545 (U.S. Army Construction Engineering Research Laboratory [CERL], 1977).

Format

The methods in this document have been numbered Corps of Engineers Test Procedures CE-TP-2001 through 2003. The MIL-STD-705B format has been followed.

Method of Reference

Test methods contained in this standard should be referenced in individual procurement documents, when applicable, by specifying this document and the method number. Equipment specifications will give specific requirements for test and limiting values.

Copies of specifications, standards, and handbooks required by the contractor in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

Mode of Technology Transfer

These procedures are for use with future Corps of Engineers guide specifications for the procurement of stationary gas turbine generator sets by reference.

2 LIST OF APPLICABLE MIL-STD-705B TEST METHODS

Method No.	Method
301.1b	Insulation Resistance Test
302.1a	High Potential Test
401.1a	Winding Resistance Test
410.1a	Open Circuit Saturation Curve Test
411.1a	Synchronous Impedance Curve Test (Short-Circuit Saturation Curve)
412.1a	Zero Power Factor Saturation Curve Test
413.1a	Rated Load Current Saturation Curve Test
415.0a	Summation of Losses Test
420.1a	Short-Circuit Ratio Test
421.1a	Direct-Axis Synchronous Reactance Test
422.1a	Negative-Sequence Reactance and Impedance Test
[illegible]a	Zero-Sequence Reactance Test
[illegible]a	Quadrature-Axis Synchronous Reactance Test
425.1a	Direct-Axis Transient Reactance Test
426.1a	Direct-Axis Subtransient Reactance Test
427.1a	Direct-Axis Transient Short-Circuit Time Constant Test
428.1a	Direct-Axis Subtransient Short-Circuit Time Constant Test
430.1a	Direct-Axis Transient Open-Circuit Time Test
432.1a	Short-Circuit Time Constant of Armature Winding Calculation
504.2a	Torsiographing Tests
505.1a	Overspeed Test (Set)
505.2a	Overspeed Protective Device Test
505.3b	Overspeed Test (Generator Only)
507.1c	Phase Sequence Test (Rotation)
508.1c	Phase Balance Test (Voltage)
509.1a	Circulating Current Test
511.1c	Regulator Range Test
511.2b	Frequency Adjustment Range Test
512.1c	Circuit Interrupter Test (Short-Circuit)
512.2c	Circuit Interrupter Test (Overload Current)
512.3c	Circuit Interrupter (Overvoltage and Undervoltage)
513.2	Indicating Instrument Test (Electrical)

Method No.	Method
515.1a	Low Oil Pressure Protective Device Test
515.2a	Overtemperature Protective Device Test
515.5	Low Fuel Protective Device Test
516.1	Controls Direction of Rotation Test
516.2	Reverse Power Protective Device Test
521.1	Paralleling Aid Device Test
601.1c	Voltage Waveform Test (Oscillographic)
601.4a	Voltage Waveform Test (Harmonic Analysis)
608.1a	Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term)
608.2	Frequency and Voltage Stability Test (Long Term)
610.1a	Voltage and Frequency Droop Test
614.1a	Voltage and Frequency Regulation Test (for Generator Sets)
619.1c	Voltage Dip for Low Power Factor Load Test
619.2b	Voltage Dip and Rise for Rated Load Test
620.1a	Voltage Unbalance With Unbalanced Load Test (Line-to-Natural Load)
620.2a	Voltage Unbalance With Unbalanced Load Test (Line-to-Line)
625.1c	Short-Circuit Test (Mechanical Strength)
630.1c	Parallel Operation Test
652.1a	Shaft Current Test
670.1a	Fuel Consumption Test
680.1b	Temperature Rise Test (Generator Only)
680.2a	Temperature Rise Test (Alternate-Loading Method)
771.1	Load Bank Test

3 LIST OF APPLICABLE CORPS OF ENGINEERS LARGE GENERATOR SET TEST METHODS

Method No.	Title
CE-TP-1001	Start and Stop Test (Manual Operation)
CE-TP-1002	Start and Stop Test (Automatic Operation)
CE-TP-1003	Voltage Waveform (Oscilloscopic)

4 SPECIFIC CORPS OF ENGINEERS TEST PROCEDURES CE-TP-2001 THROUGH 2003

Method CE-TP-2001
Field Test (Installation and Instrumentation)

2001.1 GENERAL. Field testing of the installation and instruments is a quality and safety check to insure that all electrical and mechanical components are properly installed and operating before the gas turbine generator set is operated in a power plant.

2001.2 APPARATUS. As required by the specific test procedures.

2001.3 PROCEDURE.

(a) Check for correct installation of the following:

(1) Mounting of turbine-generator set.
(2) Caulking under skid.
(3) Water hose connection.
(4) Water supply and return connected to oil cooler.
(5) Fuel inlet hose connection.
(6) Fuel supply connected to gas turbine-generator set.
(7) Turbine air inlet filter.
(8) Enclosure exhaust silencer.
(9) Turbine exhaust silencer.
(10) Turbine air inlet system.
(11) Turbine exhaust system.
(12) Generator air inlet ducting.
(13) Generator cooling air supply.
(14) Insulation.

(b) Check for correct electrical connection of the following:

(1) Critical bus switchgear.
(2) Noncritical bus switchgear.
(3) Generator control cubicle to generator interconnect wiring (control).
(4) Generator control cubicle to generator interconnect wiring (power cable).
(5) Noncritical bus to critical bus interconnect wiring.
(6) Master cubicle to generator set interconnect wiring.
(7) External cable connection.
a. Visually inspect all crimp-type lug connections to the wire.
b. Inspect power cable terminals to the setscrew-type terminal lugs and verify that the connections are tight.

(c) Check for proper installation and performance of the following:

(1) Turbine control panel.

a. Start-up system instrumentation.
b. Turbine instruments and meters.
   1. Turbine speed indicator.
   2. Turbine temperature indicator.
   3. Vibration indicator.
   4. Fuel level gage.
   5. Engine hour meter.
c. Turbine control.
   1. Control power switch.
   2. Start button.
   3. Stop button.
   4. Reset button.
   5. Speed (frequency) control.
   6. Fuel transfer switch.
d. Indicating lights.
   1. Ready-to-load indicator.
   2. Fuel transfer pump pilot light.

(2) Generator control panel.

a. Instruments and meters.
   1. Ammeter.
   2. Generator voltmeter.
   3. Bus voltmeter.
   4. Frequency meter.
   5. Kilowattmeter.
   6. Kilovarmeter.
   7. Power factor meter.
   8. Synchroscope.
   9. Watt-hour meter.
   10. Generator temperature indicator.
b. Generator control.
   1. Circuit breaker control.
   2. Ammeter selector switch.
   3. Generator voltmeter selector switch.
   4. Bus voltmeter selector switch.
   5. Synchronizing switch.
   6. Generator temperature indicator selector switch.
   7. Voltage regulator switch.
   8. Manual voltage control.
   9. Voltage adjust control.
   10. Parallel switch.
   11. Phase sequence indicator.
   12. Reactive load compensation control.

c. Indicating light.
   1. Circuit breaker position indicator.
   2. Synchronizing lights.
d. Clock

(3) Switchgear.
   a. Circuit breaker.
   b. Disconnecting switch.
   c. Operating voltage selector.
   d. Generator protective device.
      1. Overvoltage.
      2. Undervoltage
      3. Overcurrent.
      4. Synchronizing check relay.
      5. Reverse power.
   e. Annunciator alarm system
   f. Station power.
      1. Transformer.
      2. External source of station power.
      3. Station power distribution panel.

2001.4 RESULT. Submit the completed checklist covering the above procedures to the procurement officer.

2001.5 PROCUREMENT DOCUMENT REQUIREMENTS. Provide the checklist format and include all of the applicable items from CE-TP-2001 (format should include items which are required by the particular procurement specification).

Method CE-TP-2002
Field Test (Fuel and Lubrication System Demonstration Test)

2002.1 GENERAL. Field pretesting is a quality control check to insure correct installation of the electrical-mechanical equipment associated with the gas turbine-generator set operation in a power plant.

2002.2 APPARATUS. None.

2002.3 PROCEDURE. Verify completion of the following quality control procedures to the satisfaction of the contracting officer before activating any systems.

(a) Liquid fuel system.

(1) Check for correct installation of the following using the approved shop drawings:

a. Storage vessel(s).
b. Transfer equipment.
c. Storage vessel heater equipment (steam and/or electric).
d. Day tank.
e. Day tank heater equipment (hot water, steam and/or electric).
f. Piping.
g. Loading/unloading dock.
h. Fire fighting equipment.
i. Lighting.
j. Valves.
k. Relief valves.
l. Burst disc assemblies.
m. Pressure regulating valves.
n. Filters and filter assemblies.

(2) Check for completion of the following by visual inspection:

a. Cleaning of piping segments.
b. Pickling of piping segments.
c. Passivation of piping segments.
d. Hydrotesting of piping segments.
e. Dehydration of piping segments.

(3) Check for cleanliness of the following by visual inspection:

a. Storage vessel(s).
b. Transfer equipment.
c. Storage vessel heater equipment (hot water, steam, and/or electric).

d. Day tank.
e. Day tank heater equipment (hot water, steam, and/or electric).
f. Piping.
g. Loading/unloading dock.
h. Valves.
i. Relief valves.
j. Burst disc assemblies.
k. Pressure regulating valves.
l. Filters and filter assemblies.
m. Pressure gages.
n. Liquid level gages.
o. Liquid level switches.

(4) Check for satisfactory completion of leak test. If air is used for leak testing, the air must be free of moisture. Check for leaks either visually using liquid-type leak detector solution--i.e., equivalent to LEAK TEC Formula Number #372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021), or by pressure decay method as specified in the procurement document.

(5) Check that the limit switches on the day tank are adjusted to give the following:
a. Maximum liquid level limit switch to stop fuel transfer operation from the storage vessel to the day tank.
b. Minimum liquid level limit switch to start fuel transfer operation from the storage vessel to the day tank.
c. Low liquid level limit switch to signal safety shut-down of the gas turbine generator set and stop operation of the transfer pump.

(6) Check operation of the day tank and storage vessel heater.

a. High limit temperature sensing switch to give heater cutoff signal.
b. Low limit temperature sensing switch to give heater start signal.
c. Cold temperatures sensing switch.

(7) Check operation of the loading/unloading dock heater.

a. High limit temperature sensing switch to cut off heater operation.
b. Low limit temperature sensing switch to start heater operation.

c. Cold temperature sensing switch. When switch is energized, servo-operated transfer valve at the loading dock should close automatically.

Note: Fuel trailers normally have heater supplied by the tractor towing the trailer; therefore, this requirement would not apply. Neither does this requirement apply if the transfer operation is done completely by manual operation.

(8) Check operation of the storage tank, including the following, using data from the approved shop drawings:

a. Adjustment of the safety relief valve set at ____ ± _____psig.
b. Blanket gaseous nitrogen purge pressure regulator setting, if applicable, set at _____ ± _____psig.
c. Safety relief burst disc assembly for correct burst diaphragm installation. Diaphragm burst value = _____ ± _____psig.
d. Closed storage vessel drain valve.
e. Fire fighting equipment.
f. Area lighting.

(9) Check operation of the loading/unloading dock:

a. Fuel trailer and/or tank car electrical grounding circuits.
b. Fuel trailer and/or tank car transfer valves.
c. Fire fighting equipment.
d. Area lighting.
e. Proper filter installation in the filter assembly.

(10) Check operation of the storage-tank-to-day-tank transfer equipment, including the following:

a. Transfer line shutoff valve.
b. Correct rotation of the transfer pump.

Note: Do not transfer pump more than 5 minutes consecutively without liquid in the pump, otherwise pump shaft seal may be permanently damaged

c. Transfer line relief valve set at correct bypass pressure of____ ± _____psig.
d. Transfer line drain valve.
e. Automatic transfer pump start/stop operation Starting signal will come from the minimum day tank liquid level switch and the stopping signal will come from the maximum day tank liquid level switch.

f. Manual/stop operation of the transfer pump using overide switch

g. Automatic transfer pump stop operation when the low liquid level switch is energized. Insure that automatic or manual transfer pump start is inoperative when cold temperature switch in fuel line is activated.

(11) Check operation of the gravity-fed transfer line from the day tank to the gas turbine.

a. Transfer line shutoff valve at the day tank outlet.
b. Transfer line shutoff valve at the diesel engine interface.
c. Transfer line jacket heater, if applicable.

(12) Check operation of heaters in storage vessels and day tank.

a. Hot water operated system.
1. Check for correct rotation of the recirculation pump.

Note: *Do not run transfer pump more than 5 minutes* consecutively without liquid in the pump, otherwise pump shaft seal may be permanently damaged.

2. Check automatic start/stop capability of the recirculation pump on the storage vessel. The start/stop signal will be derived from the minimum/maximum temperature sensors in the storage vessel and day tank. Also check automatic stop interlock to preclude accidental overheating of the liquid fuel oil.
3. Check operation of the stirring motors in the storage and day tanks.

b. Steam operated system.
1. Check operation of the steam supply valve.
2. Check automatic operation of the servo-controlled supply value. The opening/closing signal will be derived from the minimum/maximum temperature sensors in the storage and day tanks. Also check automatic close interlock to preclude accidental overheating of the liquid fuel oil.

3. Check operation of the stirring motors in the storage and day tanks.

c. Electrically heated (resistance type) system:

1. Check manual on/off operation of the heater.
2. Check automatic on/off operation of the heater. The on/off signal will be derived from the minimum/maximum temperature sensors in the storage and day tanks. Also check that automatic off interlock precludes accidental overheating of the liquid fuel oil.
3. Check operation of the stirring motors in the storage and day tanks.

(b) Gaseous system.

(1) Check for the correct installation of the following using the approval shop drawings and manufacturer's data:

a. Accumulator
b. Filter assembly.
c. Pressure regulating valve.
d. Main fuel line shutoff valve.
e. Pressure gages.
f. Flow-metering equipment.
g. Gas turbine line shutoff valve.

(2) Check for completion of the following by visual inspection:

a. Cleaning of piping segments.
b. Pickling of piping segments.
c. Passivation of piping segments.
d. Hydrotesting of piping segments.
e. Dehydration of piping segments.

(3) Check for cleanliness of the following by visual inspection:

a. Accumulator.
b. Filter assembly.
c. Pressure regulating valve.
d. Main fuel line shutoff valve.
e. Pressure gages.
f. Flow-metering equipments.
g. Gas turbine fuel line shutoff valve.

(4) Check for satisfactory completion of leak testing. If air is used for leak testing, the air must be free of moisture. Check for leaks either visually using liquid-type leak detector solution--i.e. equivalent to LEAK TEC Formula Number 372B (American Gas and Chemicals, Inc, 511 East 72nd Street, New York, NY 10021), or by pressure decay method as specified by the procurement document.

(5) Check that flow regulator is adjusted to maintain control manifold pressure to gas turbine. Pressure at _____ ± _____psig.*

(6) Check pressure limit switch adjustment.*

a. Check operation of the maximum pressure set point switch setting at _____ ± _____psig.
b. Check operation of the minimum pressure set point switch setting at _____ ± _____psig. This switch is interlocked with the automatic shutdown sequence of the gas turbine to prevent engine failure caused by low fuel rate.

(c) Turbine lubricating oil system.

(1) Check for correct installation of the following using the approved drawings:

a. Storage tank.
b. Transfer equipment.
c. Loading/unloading dock equipment.
d. Piping.
e. Fire fighting equipment.
f. Lighting.
g. Filter assembly.

(2) Check for completion of the following:

a. Cleaning of piping segments
b. Pickling of piping segments.
c. Passivation of piping segments.
d. Hydrotesting of piping segments.
e. Dehydration of piping segments.

(3) Check for cleanliness of the following by visual inspection:

a. Storage tank.
b. Transfer eqipment.

*Use data from approved shop drawings.

c. Loading/unloading dock equipment.
d. Prelubrication circulation pump assembly.
e. Filter assembly.

(4) Check for satisfactory completion of leak testing. If air is used for leak testing, the air must be free of moisture. Check for leaks either visually using liquid-type leak detector solution--i.e., equivalent to LEAK TEC Formula Number 372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021), or by pressure decay methods as specified by the procurement document.

(5) Check adjustment of limit switches on the gas turbine lubricating oil sump.

a. Check set point of the maximum liquid level switch. The set point will be the normal maximum oil level. The limit switch shuts off the transfer pump and closes the fill valve from the storage tank to the engine sump tank.
b. Check set point of the minimum liquid level switch. The set point will be the normal minimum oil level. The limit switch starts the transfer pump operation and opens the fill valve from the storage tank to the engine sump tank.
c. Check set point of the overfill liquid level switch. The set point will be the highest oil level before gas turbine sump overflows. The limit switch shuts off the transfer pump and closes the fill valve from the storage tank to the engine sump tank.
d. Check set point of the underfill liquid level switch. The set point will be the lowest oil level before the engine sump becomes non-operational. The limit switch signals shut off of the transfer pump and fill valve and shutdown of the gas turbine.

(6) Check operation of the transfer system lube oil storage tank to the gas turbine oil sump, including the following:

a. Correct rotation of the engine prelubricating pump unit.
b. Correct rotation of the lubricating storage tank to gas turbine sump pump unit.
c. Correct pressure setting on the gas turbine prelubrication oil supply.

d. Correct pressure setting in the transfer line from storage tank to gas turbine sump.
e. Automatic start/stop of the prelube pump. Start/stop signal will be derived from the gas turbine oil pressure switch.
f. Automatic start/stop of the oil transfer pump. Start/stop signal will be derived from the minimum/maximum liquid level switch.
g. Automatic stop of the oil transfer pump and the prelube pump and gas turbine, with stop signal derived from the underfill liquid level switch. (Note: Broken oil line will be probable cause of failure.)
h. Automatic stop of the oil transfer pump, with stop signal derived from the overfill liquid level switch.
i. Manual start/stop operation of the lube oil transfer pump.
j. Manual start/stop operation of the gas turbine prelubricating oil pump.
k. Correct installation of the filter in the oil filter assembly.

2002.4 RESULTS. Included shall be a suitable quality control checklist covering the activities above. A quality control procedure is to be prepared and completed to the satisfaction of the contracting officer.

2002.5 PROCUREMENT DOCUMENT REQUIREMENT. The following items must be specified in the individual procurement document:

(a) Welding procedure.
(b) Cleaning, pickling, and dehydration procedure for piping and piping segments.
(c) Overall cleanliness requirement on equipment being installed.
(d) Leak test procedure on the following:

(1) Liquid fuel system.
(2) Gaseous fuel system.
(3) Gas turbine lubricating oil system.

(e) Specify limit switch settings on the following:

(1) Liquid fuel.
a. Nominal minimum/maximum liquid level switch setting.
b. High liquid level safety switch setting.
c. Low liquid level safety switch setting.
d. Normal minimum/maximum liquid temperature switch settings in day and storage tanks.

e. High liquid temperature switch settings in day and storage tanks.
f. Low liquid temperature switch settings in day and storage tanks.

(2) Gaseous fuel
a. High manifold safety pressure switch setting.
b. Low manifold safety pressure switch setting.

(f) Fuel requirement.
(g) Safety shutdown sequence of events.

Method CE-TP-2003
Field Test (Gas Turbine-Generator Set Demonstration Test)

2003.1 GENERAL. Field testing of the gas turbine-generator set and allied equipment--i.e., fuel transfer system, switchgear equipment, lubricating oil system, starting system, safety alarm system, safety shutdown system, and electrical sequence operation--is accomplished to demonstrate to the contracting officer that all procurement requirements have been satisfied and the power generation system is operational.

2003.2 APPARATUS. As required by the specific test procedures and the procurement document.

2003.3 PROCEDURE.

(a) Verify that all system instrumentation has been calibrated within 6 months prior to start of acceptance testing. Calibration is to be traceable to the National Bureau of Standards.

(b) Verify that appropriate fuels are loaded and transfer systems are operational.

(c) Verify that appropriate lubricating oil is loaded.

(d) Verify that gas turbine start system is operational.

(e) Verify that all electrical sequence switches and timers are set properly and operational per procurement document requirement.

(f) Conduct generator insulation resistance measurement in accordance with MIL-STD-705B method 301.1b to check dryness of the of the generator insulation. Compare the data with factory set test data.

(g) Conduct high potential test per MIL-STD-705B method 202.1a to verify that no damage occurred during transit and installation.

(h) Conduct winding resistance test per MIL-STD-705B method 401.1a to verify that no damage occurred during transit and installation. Compare data with factory set test data.

(i) Conduct the following MIL-STD-705B tests to verify correct safety switch setting:

(1) Overspeed protective device, method 505.2a.
(2) Circuit interrupter test (short circuit), method 512.1.
(3) Circuit interrupter test (overload current), method 512.2c.

(4) Circuit interrupter test (overvoltage and undervoltage), method 512.3c.
(5) Low oil pressure protective device, method 515.1a.
(6) Overtemperature protective device, method 515.2a.
(7) Low fuel protective device (turbine day tank), method 515.5.
(8) Reverse power protective device, method 516.2.

(j) Conduct the following MIL-STD-705B tests to verify correct electrical system installation.

(1) Phase sequence (rotation), method 507.1c.
(2) Indicating instrumentation test (electrical), method 513.2.
(3) Controls, direction of rotation, method 516.1.
(4) Paralleling aid device, method 521.1.

(k) Demonstrate readiness of the gas turbine generator set and allied equipment. Record any unusual event or operation:

(1) Demonstrate operation of the day tank, storage tank transfer, and heating equipment.

a. Day tank automatic fill start/stop controlled by minimum/maximum liquid level sensors (liquid fuel system).
b. Day tank automatic heater start/stop controlled by minimum/maximum fuel temperature sensors (liquid fuel system).
c. Storage tank automatic heater start/stop controlled by minimum/maximum fuel temperature sensors (liquid fuel system).
d. Day tank overfill safety shutdown.
e. Storage tank overtemperature safety shutdown, if applicable.
f. Day tank overtemperature safety shutdown, if applicable.
g. Day tank and storage tank low fuel temperature safety shutdown.

(2) Demonstrate gas regulation equipment by maintaining manifold pressure at _____psig minimum under mass flow rate of _____ + _____lbm/sec.
(3) Demonstrate lubricating oil system:

a. Lubricating oil pump operation.
b. Lubricating oil sump low oil level safety shutdown.

(4) Demonstrate operation of the start system.

(l) Conduct automatic stop test on the gas turbine-generator set to demonstrate the following fail safe sequence of events:

(1) Low lubricating oil sump tank liquid level shutdown by overriding liquid level switch.
(2) Generator set overspeed safety shutdown.
(3) Low gas manifold pressure safety shutdown.
(4) High gas manifold pressure safety shutdown.
(5) Low day tank fuel level safety shutdown by overriding automatic fill system.
(6) Electrical system transfer equipment properly transferring from commercial to standby power and back to commercial power per procurement document.

(m) Conduct automatic start/stop test on gas turbine-generator to demonstrate automatic start/stop sequence control unit.

(1) Demonstrate automatic start of generator set through automatic start sequencer. The start signal will be initiated by commercial power failure. (Figures 2003.1, 2003.2, and 2003.3). For manual stop, operator must manually reset the sequencer unit and transfer back to commercial power before the gas turbine generator set can be manually stopped.
(2) Demonstrate capability of the electrical switching equipment to change automatically from commercial to standby power and back to commercial power. Before transfer from standby to commercial power, the commercial power must be available for a specified time before the sequencer can be manually reset. Then transfer power from standby to commercial power.

2003.4 RESULTS. Provide data sheet for all data required by this TP and indicate satisfactory demonstration of the gas turbine set and its allied equipment. Note any unusual practice or operation during the demonstration.

2003.5 PROCUREMENT DOCUMENT REQUIREMENT. The following items must be specified in the procurement document:

(a) Safety shutdown sequence of the gas turbine generator set.

(b) Safety shutdown sequence of the electrical system.

(c) Types of malfunction safety shutdown to be demonstrated.

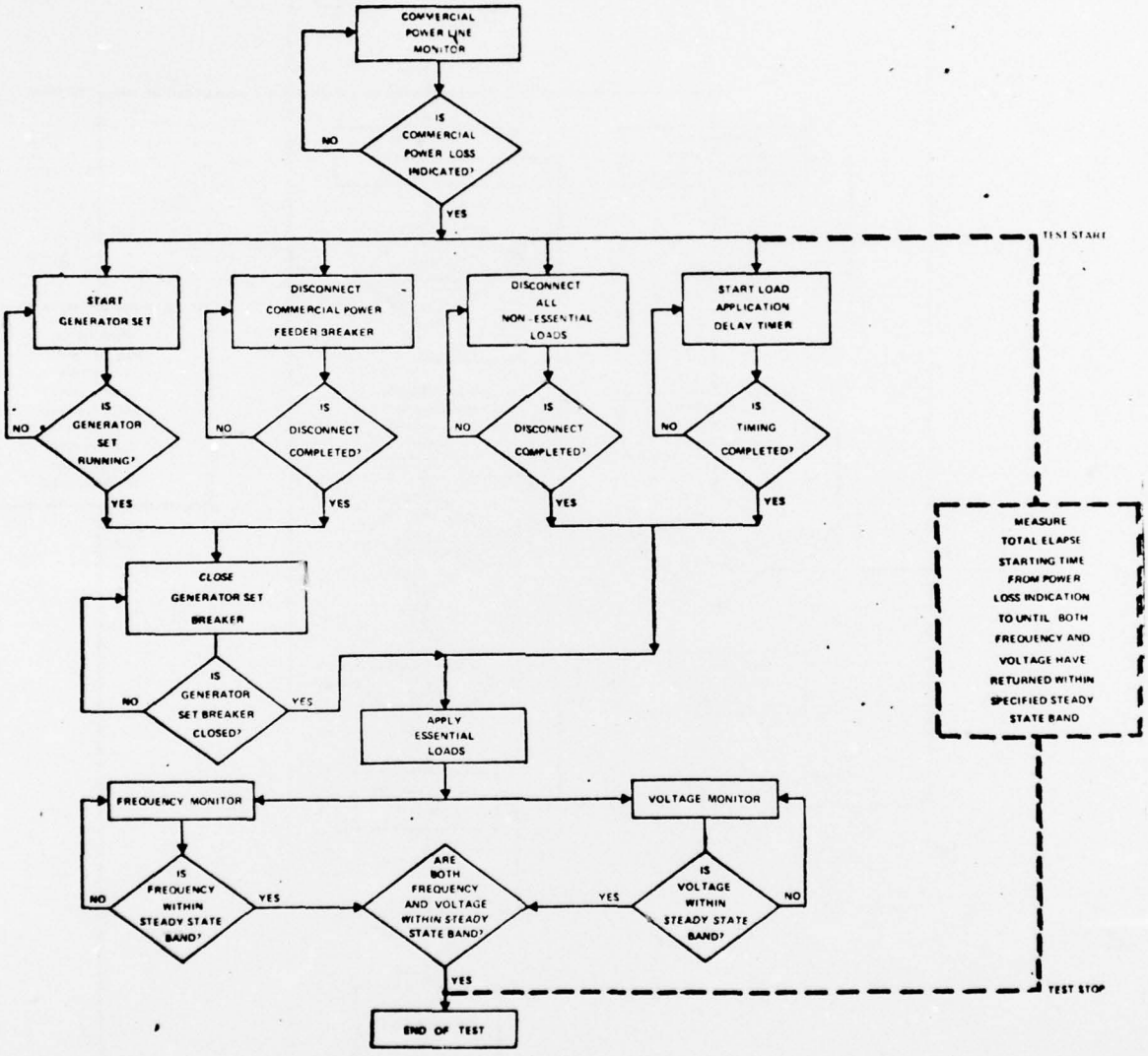


Figure 2003.1. Typical automatic start sequence test for generator set from dead stop.

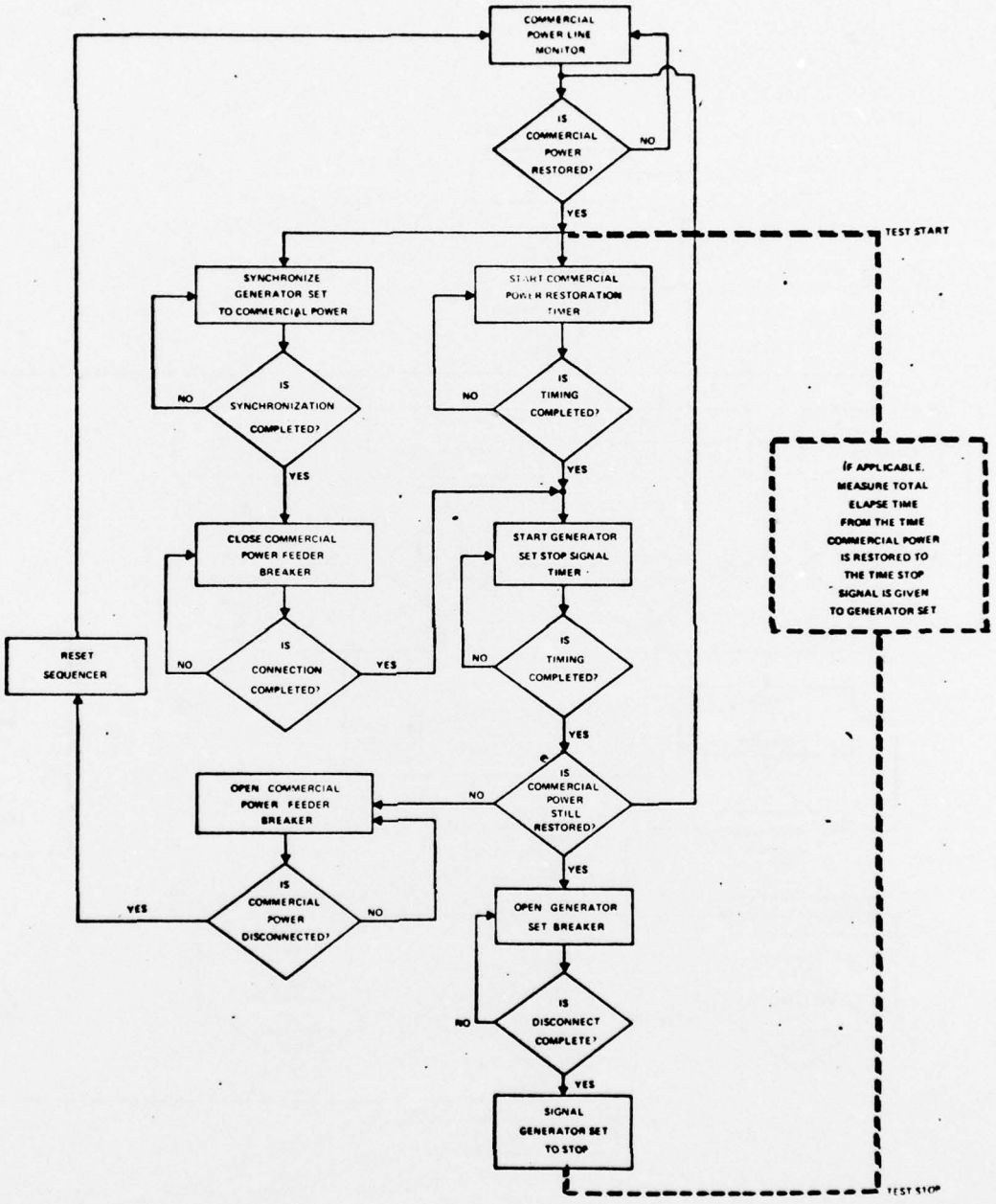


Figure 2003.2. Typical automatic sequence to transfer power source from generator set to commercial feeder and to terminate generator set operation.

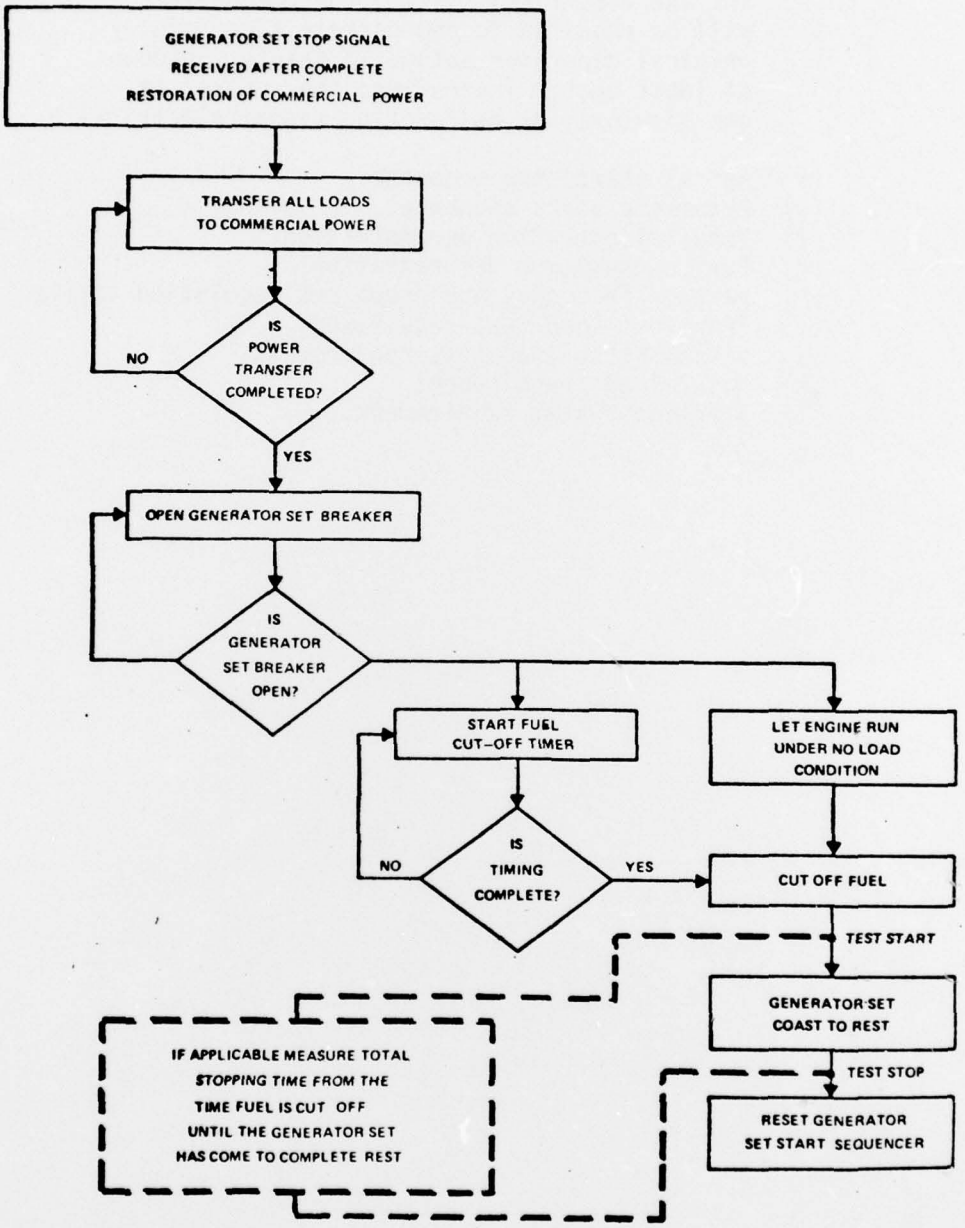


Figure 2003.3. Typical automatic stopping sequence for generator set after commercial power has been restored.

Note: If an automatic sequencer is used for safety shutdown of the gas turbine-generator set and the electrical system, the contractor will be required to demonstrate successfully physical generator automatic safety shutdown at least once. Thereafter, the contractor can simulate the malfunction signal electrically.

(d) Manual start/stop sequence.
(e) Automatic start sequence.
(f) Parallel operation demonstration.
(g) Fuel consumption demonstration.
(h) Voltage frequency and droop and regulation limits.
(i) Transient load test requirement.
(j) Steady state load test requirement.
(k) Natural gas requirement.
(l) Starting system requirement.

CERL DISTRIBUTION

Chief of Engineers
ATTN: DAEN-ASI-L (2)
ATTN: DAEN-MCE-U
ATTN: DAEN-RDL
Dept of the Army
WASH DC 20314

Defense Documentation Center
ATTN: TCA (12)
Cameron Station
Alexandria, VA 22314